NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE CORRUGATED METAL PIPELINE

(No.)

CODE 430II

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

To prevent erosion or loss of water quality or damage to the land, to make possible proper management of irrigation water, and to reduce water conveyance losses.

CONDITION WHERE PRACTICE APPLIES

This standard applies to circular corrugated metal pipe up to 48 inches in diameter and arched pipe with span and rise dimensions up to 58 inches by 38 inches.

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution or conveyance system designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

Water supplies, pipeline capacity, water quality, and rates of irrigation delivery for the area served by the pipelines shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application method to be used.

CRITERIA

Capacity. The design capacity of the pipeline shall be based on whichever of the following criteria is greater:

- The capacity shall be sufficient to deliver the volume of water required to make irrigation practical for use on the crop or crops to be irrigated.
- The capacity shall be sufficient to provide an adequate irrigation stream for the methods of irrigation to be used.

Pipeline Placement. Pipelines may be buried, placed on the ground, or above the ground.

Buried pipelines, which are subject to hazards such as traffic crossings, farm operations, freezing temperatures, or soil cracking, shall be placed deep enough to protect the pipeline. In hazardous situations the minimum cover shall be 1 foot, but in soils susceptible to deep cracking the minimum cover shall be 2 feet.

On-ground and above-ground pipelines shall be protected from hazards imposed by traffic crossings, farm operations, or other hazards.

Friction Losses. Friction head losses shall be no less than those computed with a coefficient of roughness (Manning's "n" value) as shown in **Table 1** for circular pipe. For arched pipe, use the equivalent values from **Table 2** to determine Manning's "n" value.

Working Pressure. All pipelines shall be designed for partial pipe flow except that reaches of pipe under pressure flow such as sag pipes shall have a maximum design working pressure as follows:

- 20 feet of head for annular and helical pipe with sealed seams and watertight couplings.
- 30 feet of head for helical pipe with welded seam, annular ends, and watertight couplings.

Pipe with the seams not sealed may be used under partial flow conditions. Watertight couplings shall be used for this condition.

External Load Limit. Fill heights shall not exceed the maximum depths given in **Tables 3, 4,** and **5**, for the gauge, size, and shape of pipe given.

Table 1
Manning's "n" for Circular Corrugated Metal Pipe [1/]

Diameter (in.)	Area (sq. ft.)	Helical	Annular	Annular 25% Paved	Helical 25% Paved
1½" x ¼					
6	0.20				
8	0.35	0.013			
10	0.55	0.016			
2⅔" x ½" [2/]					
12	0.79	0.011	0.026		
15	1.23	0.013	0.025		
18	1.77	0.014	0.025		
21	2.41	0.016	0.025		
24	3.14	0.017	0.025	0.021	
30	4.91	0.018	0.025	0.021	0.016
36	7.07	0.019	0.025	0.021	0.017
42	9.62	0.020	0.024	0.024	0.019
48	12.57	0.020	0.024	0.021	0.020
3" x 1"					
30	4.96	0.019	0.027	0.023	0.010
36	7.07	0.020	0.027	0.023	0.019
42	9.62	0.020	0.027	0.023	0.019
48	12.57	0.020	0.027	0.023	0.019

[1/] 'n' values based on test results from St. Anthony Falls Hydraulic Laboratory, Minn.
[2/] Some helical corrugations have a depth of 7/16 in., use value for ½ in.

Table 2
Equivalent Values for Arched Pipe for Selecting Manning's "n" [3/]

Aluminum		Steel		Diameter of Pipe of Equal Periphery (inches)
Size (inches) Span Rise	Area (sq.ft.)	Size (inches) Span Rise	Area (sq.ft.)	
17 13	1.2	18 11	1.1	15
21 15	1.7	22 13	1.6	18
24 18	2.3	25 16	2.2	21
28 20	2.9	29 18	2.8	24
35 24	4.4	36 22	4.4	30
42 29	6.5	43 27	6.4	36
49 33	8.4	50 31	8.7	42
57 38	11.3	58 36	11.4	48

[3/] To determine 'n' value for arched pipe, select equivalent circular pipe diameter and go to Table 1 to select 'n' for appropriate corrugation configuration.

Table 3
Maximum Depth of Cover (Feet) for Steel Corrugated Circular Pipe, H-20 loading

Specific Thickness → (inches)	0.040	0.060	0.075	0.105	0.135	0.165
Gage →	18	16	14	12	10	8
Diameter (in) ↓						
1½" x ¼"						
6	**55**	**77**				
8	**33**	**43**				
10	**25**	**30**				
2⅔" x ½"						
30			**20**	**21**	**22**	
36			**19**	**19**	**20**	
42				**18**	**19**	
48				**18**	**18**	**19**
3" x 1"						
30		**29**	**29**	**35**	**40**	
36		**24**	**24**	**27**	**31**	
42		**21**	**21**	**23**	**26**	
48		**20**	**20**	**21**	**23**	**24**

Table 4
Maximum Depth of Cover (Feet) for Aluminum Corrugated Circular Pipe, H-20 Loading

Specific Thickness → (inches)	0.052	0.064	0.079	0.109	0.138	0.168
Gage →	18	16	14	12	10	8
Diameter (in) ↓						
1½" x ¼"						
6		200				
8		90				
10		51				
2⅔" x ½"						
12	98	119	145			
15	58	69	83			
18	41	47	55			
21	32	36	41	51		
24	27	30	33	40		
27		24	28	33		
30		24	25	29		
36		21	22	24	26	
42		19	20	21	23	24
48		18	19	20	21	22
3" x 1"						
36	31	25	39	48	57	67
42	26	25	31	36	42	48
48	23	20	26	30	34	38

Table 5

Maximum Depth of Cover (Feet) for Aluminum and Steel Corrugated Arched Pipe, H-20 Loading

Aluminum; Helical and Riveted - 2⅔" x ½"		
Size (inches) Span Rise	Gage	Maximum Depth (feet)
17 13	16	13
21 15	16	13
24 18	16	12
28 20	14	11
35 24	14	11
42 29	12	10
49 33	12	10
57 38	10	9
Steel - 2⅔" x ½		
Size (inches) Span Rise	Gage	Maximum Depth (feet)
18 11	16	13
22 13	16	12
25 16	16	10
29 18	16	9
36 22	16	9
43 27	16	7
50 31	14	7
58 36	12	7
Steel - 3" x 1"		
Size (inches) Span Rise	Gage	Maximum Depth (feet)
43 27	16	12
50 31	16	12
58 36	16	12

Note:

Gages shown for information purposes only.

Corner bearing pressures assumed to be 2 tons per square foot for maximum depths given. Maximum depth cover based on maximum 5% deflection. Re. U.S. Department of Commerce/Bureau of Public Roads, Corrugated Metal Pipe Culverts Structural Design Criteria and Recommended Installation Practice, U.S. Government Printing Office, June 1966, p. 14, 25.

Vents. Air and vacuum release valves or vents shall be designed into the pipeline where needed.

Drainage and Flushing. Provisions shall be made for completely draining the pipeline if freezing temperatures impose a hazard or if drainage is specified for the job.

If required, drainage outlets shall be located at all low places in the line. These outlets may drain into dry wells or to points of lower elevation. Drainage and flushing points shall be located to minimize erosion potential and to minimize ponding of water at undesirable locations. If drainage cannot be provided by gravity, provisions shall be made to empty the line by pumping.

Outlets. Appurtenances for delivering water from a pipe system to the land, to a ditch, or to a surface pipe system shall be known as outlets. Outlets shall have the capacity to deliver the required flow:

- To a point at least 6 inches above the highest field elevation.
- To the hydraulic grade line (HGL) of a pipe or ditch.

Pipe Supports. Irrigation pipelines placed above ground shall be supported by suitably built concrete, steel, or timber saddles shaped to support the pipe throughout the arc of contact, which shall be not less than 90 degrees nor more than 120 degrees as measured at the central angle of the pipe.

If needed to prevent overstressing, ring girder-type supports shall be used.

Support spacing shall ensure that neither the maximum beam stresses in the pipe span nor the maximum stress at the saddle exceed the design stress values.

Thrust Control. Aboveground pipelines shall have the movement of each pipe length restrained by steel hold-down straps at the pipe supports or by anchor blocks instead of normal pipe supports.

Anchor blocks usually are not required on buried pipelines.

Thrust blocks shall be required on **aboveground** pipelines at all points of abrupt changes in grade, horizontal alignment, or reduction in size. The blocks must be of sufficient size to withstand the forces tending to move the pipe, including those of momentum and pressure, as well as forces due to expansion and contraction.

Joints and Connections. All connections shall be designed and constructed to withstand the working pressure of the line without leakage and to leave the inside of the pipeline free of any obstruction that would reduce the line capacity below design requirements.

Corrosion Protection. When cathodic protection is required, joints shall be bridged to ensure continuous flow of current.

A dielectric connection shall be placed between pipes with different coatings.

If connected directly to a pump, a dielectric connection shall be placed between the pump and the pipeline.

All fittings, such as risers, elbows, tees, and reducers, should be of similar metals. If dissimilar metals are used, the fittings shall be protected against corrosion. For example, separate dissimilar metals with a rubber or plastic insulator.

Bolts used to join galvanized steel must be galvanized, plastic coated, or otherwise protected to prevent galvanic corrosion. Bolts used to join aluminum, other than aluminum alloy bolts, must be galvanized, plastic coated, or other wise protected to prevent galvanic corrosion.

Interior protective coatings shall be provided when the pH of the water is less than, or greater than, the values shown in the following chart:

Material	Water pH
Aluminized steel	5 - 9
Galvanized steel	6 - 10
Aluminum alloy	4 - 10

Hot dipped asphalt, or polymeric coated galvanized, or aluminized steel pipe shall be provided if the soil resistivity along any part of the pipeline is between 3000 and 4000 ohm-cm. Cathodic protection, in addition to the above coatings, shall be provided for galvanized steel pipe if the soil resistivity is less than 3000 ohm-cm. Aluminized steel pipe shall not be used when the soil resistivity is less than 3000 ohm-cm.

Galvanized or aluminized steel pipe shall be used when the soil resistivity is greater than 4000 ohm-cm, or aluminum alloy pipe may be used when the soil resistivity is greater than 500 ohm-cm. Aluminum alloy pipe shall not be used when the soil resistivity is less than 500 ohm-cm or soil pH is less than 4 or greater than 9.

Cathodic Protection. The total current required may be estimated from the formula:

$I_t = C\ [A1/\ R_e1 + A2/\ R_e2 + \ldots\ An/\ R_en]$

Where:

I_t = total current requirement in mA
A = surface area of pipe in square feet
R_e = soil resistivity in ohm-cm
C = a constant for a given pipe coating

The constant C shall be considered to be not less than 32 for Class A coatings and not less than 60 for Class B coatings.

The kind of galvanic anode to be used depends on the resistivity of the soils in the anode bed location. If the resistivity of the anode bed is:

- Less than the 2,000 ohm-cm, a zinc anode shall be used;
- Between 2,000 and 3,000 ohm-cm, either zinc or magnesium anodes shall be used.

The number of anodes needed to protect the pipeline may be estimated by dividing the total cathodic current requirement of the pipeline by the current output per anode.

Thus:

$N = I_t/I_m$ and $I_m = k/R$

Where:

N = number of anodes needed
I_t = total current requirement in mA
I_m = maximum anode current output in mA
k = constant for a given anode
R = soil resistivity of the anode bed, ohm-cm

The expected life of an anode, based on the use of 17 lb/ampere year for magnesium and 26 lb/ampere year for zinc and a utilization factor of 0.80, shall be computed as follows:

Magnesium……..$Y = 47W/I_o$
Zinc……...$Y = 31W/I_o$

Where:

Y = expected life in years
W = weight of anode in pounds
I_o = design anode current in mA = I_m unless resistors are used in the anode circuit to reduce output

If resistors are used to reduce anode current output to increase service life, the number of anodes required shall be based on the regulated output of the anode rather than on the maximum output, I_m.

Preliminary soil-resistivity measurements to determine coating requirements and the approximate amount of cathodic protection needed may be made before the trench is excavated. For this purpose, field resistivity measurements shall be made, and samples for laboratory analysis shall be taken at least every 400 feet along the proposed pipeline and at points where there is a visible change in soil characteristics. If a reading differs markedly from a preceding one, additional measurements shall be taken to locate the point of change. Resistivity determinations shall be made at two or more depths in the soil profile at each sampling station; the lowest depth shall be the stratum in which the pipe will be laid. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station.

After the pipe trench is excavated, a detailed soil resistivity survey shall be made as a basis for final design of the coating and the required cathodic protection. At this time, resistivity measurements shall be made in each exposed soil horizon at intervals not exceeding 200 feet. The lowest value of soil resistivity found at each sampling station shall be used as the design value for that station. If design values for adjacent stations differ significantly, additional intermediate measurements shall be made.

In many New Mexico sites, this standard will be used to design pipelines that will be installed in a location now occupied by an existing, unlined irrigation ditch. Care should be taken when conducting soil resistivity measurements to assure that these measurements reflect the future soil and moisture conditions of the pipeline environment.

Anodes. Horizontally placed anodes shall be at or below the bottom elevation of the pipeline. Vertically placed anodes shall have a minimum distance of 3 feet between the ground surface and the top of the anode. Anodes shall not be placed in fill areas, and magnesium anodes must be placed a minimum distance of 10 feet from the pipeline.

The lead wire from the anode, or the header wire for multiple anode installations, shall be attached to the pipeline by cadwelding, thermowelding, or other similar processes. The area of damaged pipe coating and the weld shall then be covered with a coating equal in quality to that of the specified original pipe coating.

Abrasion Protection. An interior asphalt coating and invent-paving shall be used where abrasion will be a problem.

Materials. All materials shall meet or exceed the minimum requirements of this standard.

CONSIDERATIONS

Effects on the water budget, especially on infiltration and evaporation.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential use for irrigation water management.

Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

Effects of replacing other types of conveyances by installing a pipeline, on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water.

Effects on the movement of dissolved substances into the soil and on percolation below the root zone or to ground water recharge.

Effects of controlled water delivery on the temperatures of water as it affects aquatic and wildlife communities.

Effects on wetlands or water-related wildlife habitats.

Effects on the visual quality of water resources.

Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities.

DRAWINGS AND SPECIFICATIONS

Drawings and specifications for corrugated metal irrigation pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATIONS AND MAINTENANCE

Provisions shall be made as necessary for operations and maintenance requirements and may include a formal plan.

The pipe will be checked for leaks and evidence of leaks on an annual basis.

Pipe supports will be checked, on an annual basis, for erosion and animal or human activity that may damage or affect the proper operation or integrity of the pipe.

Any damage will be promptly repaired

REFERENCES

Western Nation Technical Center Interim Standard, January 1983

Engineering Field Handbook

National Engineering Manual

Manual of Steel Construction, American Institute of Steel Construction

Timber, National Design Specification for Wood, American Forest and Paper Association

Concrete, ACI 318, American Concrete Institute

Masonry, Building Code Requirement for Masonry Structures, ACI 530, American Concrete Institute